2 INITIAL ASSESSMENT OF MATERIALS AND EQUIPMENT

2.1 Introduction

The Initial Assessment (IA) is the first step in the investigation of materials and equipment (M&E), similar to the Historical Site Assessment (HSA) described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM 2002). The purpose of the IA is to collect and evaluate information about the M&E in order to determine if it is impacted or non-impacted (i.e., categorization). During the IA process, additional information is collected to identify and support potential disposition of impacted M&E (e.g., clearance, increased radiological controls, remediation, or disposal). Project Managers are encouraged to use the IA to evaluate M&E for other hazards (e.g., lead, PCBs, asbestos) that could increase the complexity of the disposition survey design or pose potential risks to workers during subsequent survey activities (see Section 5.2), or to human health or the environment following subsequent disposition of the M&E.

There are five major activities associated with the performance of the IA:

- Categorize the M&E as impacted or non-impacted based on visual inspection, historical records, process knowledge, and results of sentinel measurements (Section 2.2).
- Design and implement preliminary surveys to adequately describe the M&E and address data gaps based on a preliminary description of the M&E (Section 2.3).
- Describe the physical and radiological attributes of the M&E (Section 2.4).
- Select appropriate disposition option(s) and define alternative actions applicable to impacted M&E (Section 2.5).
- Document the results of the IA through the use of a standard operating procedure (SOP) or development of a conceptual model (Section 2.6).

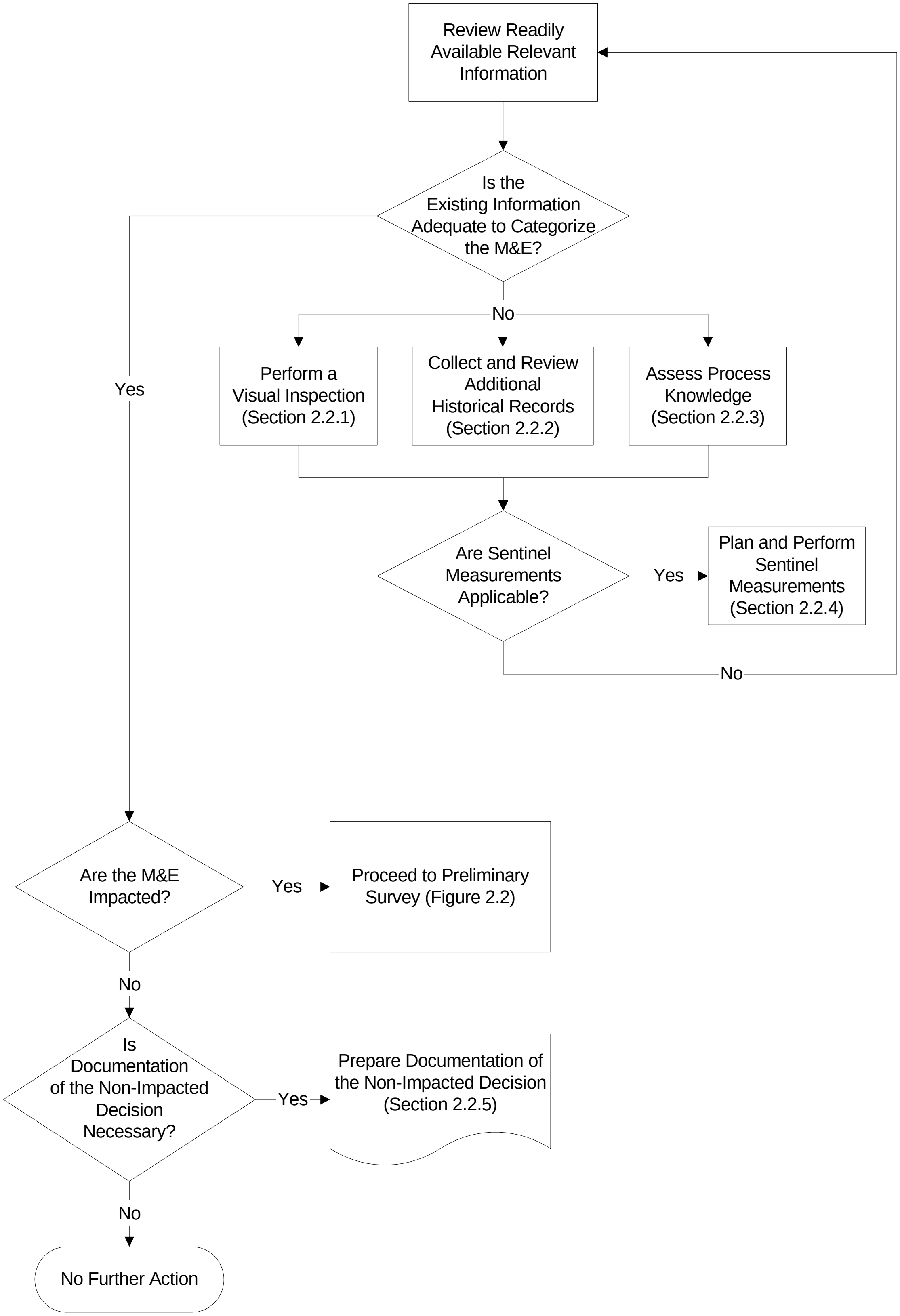
For M&E that have been categorized as impacted, an existing survey design in the form of an SOP may be available for investigating the radiological status of the M&E. If an applicable SOP is available, the instructions in the SOP should be followed for implementing and assessing the results of the survey. The information on performing preliminary surveys (Section 2.3) can be used to determine whether an SOP is applicable to the M&E being investigated. The information on describing the M&E (Section 2.4) can be used to determine if preliminary surveys are necessary. The information on selecting a disposition option (Section 2.5) and documenting the results of the IA (Section 2.6) can be used for project-specific applications, or for developing a new SOP.

2.2 Categorize the M&E as Impacted or Non-Impacted

The first decision made when investigating M&E is whether they are impacted or non-impacted. M&E with no reasonable potential for containing radioactivity in excess of natural background, fallout levels, or inherent levels of radioactivity are non-impacted. Impacted M&E have a reasonable potential to contain radionuclide concentration(s) or radioactivity above background.

The decision of whether M&E are impacted or non-impacted is primarily based on existing information. Figure 2.1 describes the categorization process. If adequate information is readily available to support a categorization decision, the decision maker should decide if the M&E are impacted or non-impacted. A complex piece or group of M&E may be divided into portions that are impacted and portions that are non-impacted. This is illustrated in the front loader example described in Section 7.4, where the bucket and tires may be impacted while the engine and cab interior are non-impacted. If additional information is required to support the categorization decision, visual inspection (Section 2.2.1), collection and review of historical records (Section 2.2.2), and assessment of process knowledge (Section 2.2.3) are the most common sources of additional existing information. Assumptions may be made regarding the use and interpretation of existing information. Data collection activities may be performed during the IA to specifically address questions about these assumptions. These data collection activities are called sentinel measurements and are discussed in Section 2.2.4.

Additional investigation is required to make technically defensible disposition decisions regarding impacted M&E. All impacted M&E must receive some level of additional investigation, even if the expected disposition is disposal as radioactive waste. For example, M&E shipped for disposal as radioactive waste must meet waste acceptance criteria at the disposal facility as well as Department of Transportation (DOT) requirements for transporting



57 **Figure 2.1 The Categorization Process as Part of Initial Assessment**

radioactive material. The results of any additional investigation must clearly demonstrate compliance with any applicable requirements, and be appropriately documented. Non-impacted M&E do not receive any additional radiological investigation.

2.2.1 Perform a Visual Inspection

The purpose of the visual inspection is to identify and document the physical characteristics of the M&E (e.g., size, kind of material, shape, and condition) when this description is not readily available to support a categorization decision. The visual inspection may be performed during a site visit, or by reviewing photographs or videos of the M&E. Photographs and video also provide a means for documenting the results of the visual inspection. The visual inspection corresponds to the Site Reconnaissance presented in Section 3.5 of MARSSIM. Information will be used to support the following activities:

- Developing survey unit boundaries (Section 3.6).
- Defining the parameter of interest during the development of a decision rule for impacted M&E (Section 3.4).
- Verifying the requirements of an SOP are met before performing a routine survey (Section 4.5.1).
- Evaluating any health and safety concerns (Section 5.2).
- Developing handling protocols for implementation of the disposition survey (Section 5.3 and 5.4).

Prior to performing a visual inspection, the surveyor should review what is known about the M&E. If little or no information is available describing potential hazards associated with the M&E, care should be exercised in performing a visual inspection. Screening measurements for radiation, chemical, and other hazards, along with the use of personal protective equipment (e.g., gloves, coveralls, respirators), may be necessary depending on available information. Situations with known or expected risks (i.e., M&E that are radiologically or chemically impacted) may require preparation of a study plan or SOP anticipating activities to be performed and identifying specific information to be collected. Casual visual inspections of M&E with an unknown history are not recommended. Detailed visual inspections (e.g., disassembly of potentially impacted equipment to examine interior surfaces) should not be performed without proper precautions and are more appropriately handled by performing preliminary surveys (Section 2.3).

While the primary objective for performing a visual inspection is to collect information used to design a disposition survey, the information can be used for other purposes. Development of handling protocols for implementation of the disposition survey (see Section 5.3) and evaluation of health and safety concerns (see Section 5.2) are two examples where visual inspection information would be used.

2.2.2 Collect and Review Additional Historical Records

Historical records may provide specific information on the identity, concentration, and distribution of radioactivity when these types of records are not readily available to support a categorization decision. Information on the physical characteristics of the M&E (e.g., size, shape, condition) and the characteristics of the radioactivity (e.g., radionuclides of concern, expected concentrations) will be used to select a disposition option in Section 2.5 and describe initial survey unit boundaries in Section 3.6.1. The historical information is then used to define the action level, parameter of interest, and alternative actions during the development of a decision rule for impacted M&E (Section 3.7, EPA 2006a).

Types of historical records that provide useful information are described in MARSSIM Section 3.4.1, and may include:

- A facility or site radioactive materials license;
- Permits or other documents that authorize use of radioactive materials;
- Other permits and environmental program files;
- Operating records (e.g., previous surveys, waste disposal records, effluent releases);
- Corporate contract files (e.g., purchasing records, shipping records);
- A site or facility description (e.g., locations of M&E, site photographs).

Another source of historical information is interviews with current or previous employees. Interviews may be conducted early in the data collecting process or close to the end of the IA. Interviews conducted early in the IA cover general topics, and information gathered is used to guide subsequent data collection activities. Interviews conducted late in the IA allow the investigator to direct the investigation to specific areas that require additional information or clarification.

Once the historical records have been collected, they should be reviewed to identify information that supports the categorization decision. Historical information used to support the categorization decision should be evaluated using the Data Quality Assessment (DQA) process (EPA 2006b). In particular, historical information should be examined carefully because:

- Previous data collection efforts may not be compatible with IA objectives;
- Previous data collection efforts may not be extensive enough to fully describe the M&E being investigated;
- Measurement techniques or protocols may not be known or compatible with IA objectives;
- Conditions may have changed since the data were collected.

Additional information on evaluating data can be found in the following documents:

- The Environmental Survey Manual Appendix A - Criteria for Data Evaluation (DOE 1987);
- Upgrading Environmental Radiation Data, Health Physics Committee Report HPSR-1 (EPA 1980);
- Guidance for Data Usability in Risk Assessment, Part A (EPA 1992a);
- Guidance for Data Usability in Risk Assessment, Part B (EPA 1992b).

Historical records describing impacted M&E may include additional information that can be used to support additional activities during the disposition process. For example, historical records may provide descriptions of the M&E that are sufficient to design a disposition survey (Chapter 4). On the other hand, the historical records can be used to identify data gaps that are addressed by performing preliminary surveys (Section 2.3).

2.2.3 Assess Process Knowledge

The characteristics, history of prior use, and inherent radioactivity are critical for evaluating the impacted status of M&E. This information is termed process knowledge. Process knowledge is obtained through a review of the operations conducted in facilities or areas where M&E may have been located and the processes where M&E were involved when this information is not readily available to support a categorization decision. This information is used to evaluate whether M&E—such as structural steel, ventilation ductwork, or process piping—had been in direct contact with radioactive materials or had been activated, which would lead to a decision the M&E are impacted. Descriptions of the physical attributes of the M&E (see Section 2.4.1) and radiological attributes of the M&E (see Section 2.4.2) can be obtained from process knowledge. In addition, process knowledge supports the selection of a disposition option (see Section 2.5). The disposition option is then used to identify sources of action levels, a parameter of interest, and alternative actions during the development of a decision rule for impacted M&E (Section 3.7, EPA 2006a).

Process knowledge is obtained by researching the M&E and understanding the origin, use, and potential disposition. The level of detail required from process knowledge is project specific. The description of M&E could be simple, such as a set of hand tools being removed from a controlled area where the radiological conditions are well known. At the other extreme is a complex situation that requires knowledge of the manufacturing process, investigations of multiple processes that could impact the radiological conditions associated with the M&E, and understanding of recycle and reuse options that include movement of radionuclides through the environment. Sections 2.4.1 and 2.4.2 describe types of information that may be obtained from process knowledge and are necessary to support the development of a disposition survey.

In some cases, process knowledge of the equipment being investigated can be used to support categorization decisions. Consider a pump used to circulate demineralized make-up water. Maintenance records do not show the presence of radioactivity and operating records indicate no events where the pump could have been used with radioactivity. Radiological samples of the demineralized make-up water do not show the presence of radioactivity. Based on this process knowledge, the interior of the pump is categorized as non-impacted.

Historical records (see Section 2.2.2) are one source of process knowledge. Historical records, including interviews, provide site- and project-specific information on historical use and radiological processes that may affect the M&E. Engineering and chemistry books and journals provide information on the origins (e.g., manufacturing) and potential disposition of the M&E. Industry documents and company records are also potential sources of process knowledge.

Other sources of information on M&E should be considered during the IA, indicating how, where, and when the M&E were used in areas where they potentially could have been affected by radionuclides or activation. These sources of information include:

- purchasing records showing when M&E were obtained
- maintenance records showing where and how they were used
- operating logs for systems which utilized or could have affected the M&E,
- disposal records showing survey results for similar types of M&E indicating types and locations of radionuclides or radioactivity

In some instances, process knowledge may not be available for the M&E being considered for release. For example, consider an outdoor material staging area for a nuclear facility where various pieces of surplus equipment and metal have accumulated over the years. The origin of these M&E is unknown. In this case, it is particularly important that preliminary surveys be performed on the M&E to determine if excess radioactivity is present and to finalize the list of radionuclides of concern.

Techniques used to protect equipment or prevent radioactivity from entering difficult-to-measure areas or penetrating porous surfaces can be used to support categorization decisions. Consider the following examples of protection and prevention techniques:

- Plan and coordinate all work to minimize exposure of equipment, tools, and vehicles to radioactivity.
- Evaluate materials, tools, and equipment for ease of decontamination and disassembly (that may be required for decontamination or release) prior to use.
- Use prefilters or have a separate source of outside air on the intake for internal combustion equipment subject to airborne radionuclides or radioactivity.
- Use a filtered inlet for high volume air handling equipment such as blowers, compressors, etc., to minimize the potential for internal contamination due to build up of low-level radioactivity.
- Do not bring electrically driven mobile equipment into controlled areas.
- Use protective sheathing/covers, strippable coatings, or protective caps to minimize the potential for surficial radionuclides or radioactivity.

- Cover and protect all openings on equipment, tools, or vehicles that may permit radioactivity to enter difficult-to-access or difficult-to-clean areas.
- Select technologies that minimize radiological airborne emissions, secondary wastes, and tool or equipment damage.

2.2.4 Perform Sentinel Measurements

Sentinel measurements are biased measurements performed at key locations to provide information specific to the objectives of the IA. The objective of performing sentinel measurements as part of the IA is to gather sufficient information to support a decision regarding further action (e.g., categorization). Sentinel measurements may also be used to verify assumptions based on existing information or obtain information on the current status of the M&E. Sentinel measurements are not a risk assessment, scoping survey, or study of the full extent of radionuclides or radioactivity associated with the M&E.

Sentinel measurements alone cannot be used to show that M&E are non-impacted. Positive results are definitive for determining that M&E are impacted. However, negative results provide only part of the evidence required for determining that the M&E are non-impacted. Since radioactivity in difficult-to-measure areas cannot be measured directly without accessing the area (e.g., disassembling equipment), sentinel measurements performed at access points to difficult-to-measure areas could be used to indicate that it is unlikely that radioactivity entered that area. Because sentinel measurements are usually associated with difficult-to-measure areas, they are not generally applicable to dispersible bulk materials.

If protection and prevention techniques (described in Section 2.2.3) were applied to equipment used around radioactive material, sentinel measurements can be used in connection with process knowledge to support a decision of whether difficult-to-measure areas were impacted. For example, if prefilters are used to capture particulate airborne radioactivity of a specific size before the particulates enter difficult-to-measure areas, sentinel measurements can be made on the prefilters.

It should be noted that access points are often modified to limit personnel radiation exposure to difficult-to-measure areas after use (e.g., capped, sealed, cleaned). Care should be taken to avoid performing sentinel measurements at modified access points to reduce the probability of making an incorrect decision about the status of the M&E. QA and QC should be considered during planning for collection of sentinel measurements. The measurement and subsequent evaluation of the results should be consistent with the assumptions used to define sentinel measurements.

2.2.5 Decide Whether M&E are Impacted

Once there is adequate information to support a categorization decision, the decision maker needs to decide whether the M&E are impacted or non-impacted. The categorization decision is built on four sources of information: visual inspection, historical records review, process knowledge, and the results of sentinel measurements.[1] If the results for any part of the categorization process indicate a reasonable potential for radionuclide concentrations or radioactivity above background, the decision is the M&E are impacted. For example, if the visual inspection, historical records, and process knowledge all indicate the M&E are non-impacted but the sentinel measurements indicate impacted, the M&E are impacted. Similarly, if the visual inspection and sentinel measurements indicate the M&E are non-impacted but the historical records and process knowledge indicate the M&E are impacted, the M&E are impacted. An important point is that sentinel measurements alone cannot be used to support a decision in declaring M&E as non-impacted.

In most cases, the categorization decision is obvious based on the available information. In cases where the decision is not obvious, the consequences of making a decision error usually result in a determination that the M&E are impacted. For example, the consequence of incorrectly categorizing M&E as impacted when they are not impacted includes performing a radiological survey. However, the consequence of incorrectly categorizing M&E as non-impacted when they are impacted could result in inadvertent exposure for members of the public and lack of confidence in other radiological decisions.[2]

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[1] Sentinel measurements are not required to support a categorization decision. If sentinel measurements are performed they should be evaluated to determine the categorization of the M&E.

[2] The consequences of incorrectly categorizing M&E are also discussed in Section 4.3.4.

Collectively, this information should be used to develop survey strategies targeting different types of materials in recognition that a single survey method or procedure may not necessarily fit the technical requirements of all materials, given their diverse properties. For example, one procedure may be used to address only the routine releases of tools and equipment. On the other hand, a separate procedure may be developed to address infrequent releases of large amounts of bulk materials, such as concrete rubble. The approach suggested here is one of compartmentalizing the release activities into manageable and common functional elements with each one being optimized in the context of facility operations as to its effectiveness, while demonstrating compliance with applicable regulations. The development of standardized survey procedures for infrequent releases necessitates that the MARSAME user utilize processes in the remainder of this chapter and then move to Section 3.10 for evaluating and implementing standard operating procedures (SOPs).

If there is insufficient information available to design a disposition survey following categorization, preliminary surveys may be performed to obtain additional information describing the physical and radiological characteristics of the M&E (this is described in Section 2.4). These preliminary surveys facilitate the development of an effective and efficient disposition survey design.

The decision maker should consider whether documentation of the M&E categorization decision is necessary or not for M&E that are categorized as non-impacted, since no additional investigation is required. In most cases it is not necessary to document decisions that M&E are impacted since this decision will be documented later in the disposition process (e.g., documentation of the IA results in Section 2.6, documentation of the survey design in Section 4.5, and documentation of the disposition survey results in Section 6.6).

2.3 Design and Implement Preliminary Surveys

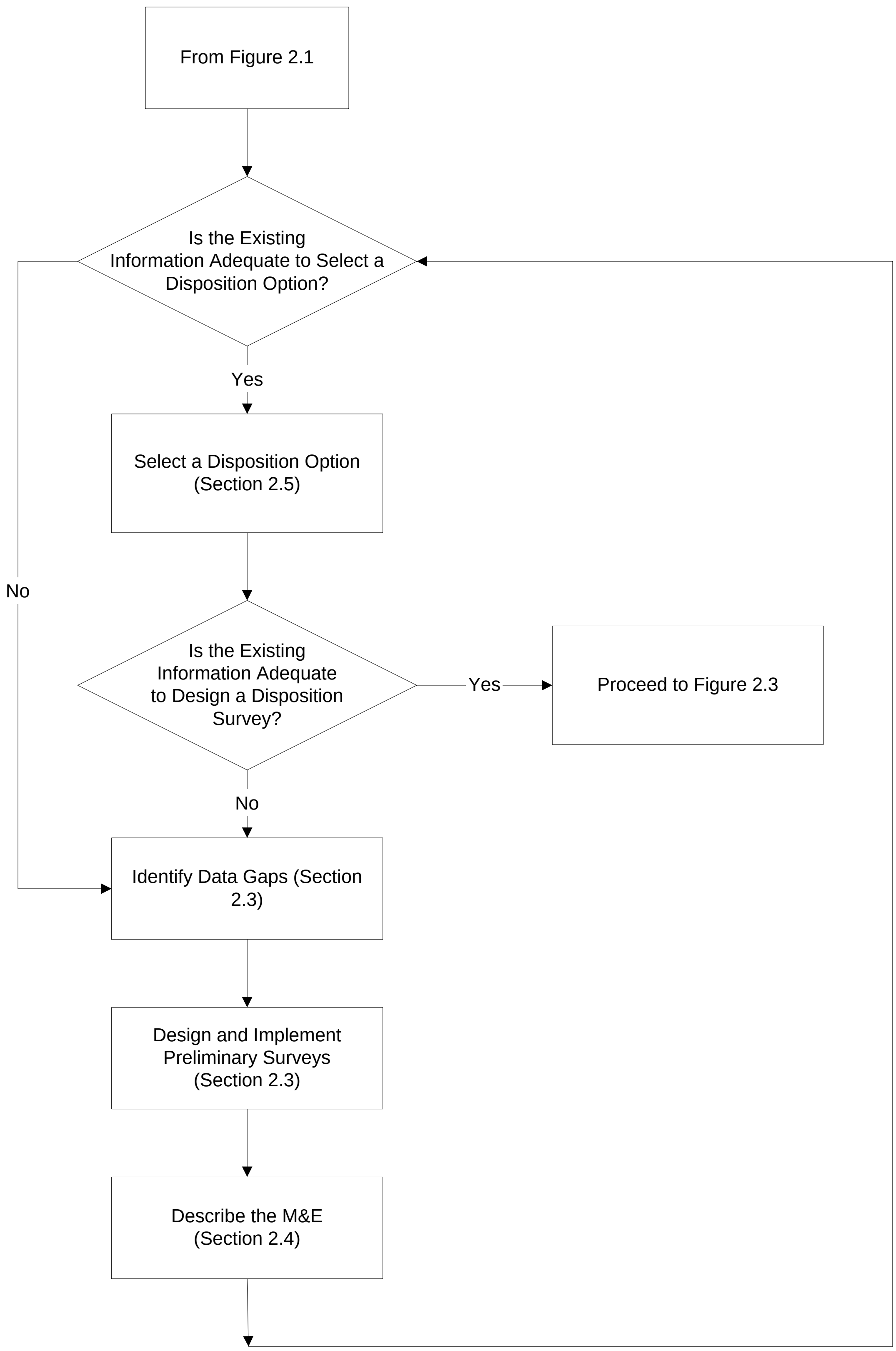
If there is insufficient information available to design a disposition survey following categorization, it may be necessary to perform preliminary surveys to obtain the required information. Preliminary surveys of M&E correspond to scoping and characterization surveys described in MARSSIM Sections 5.2 and 5.3.

Following a decision that the M&E being investigated are impacted, the decision maker should determine if an applicable standardized survey design is available, usually in the form of an SOP. If an SOP is available and applicable to the M&E being investigated, the instructions in the SOP should be implemented and the results of the survey evaluated as specified in the SOP (see Figure 2.2 and Section 2.6.1).

It may be necessary to evaluate the quantity and quality of data describing the M&E to determine if the existing data are adequate for implementing an existing SOP or developing a disposition survey design. If the data are adequate, no additional data collection is required. On the other hand, if there are data gaps that need to be addressed prior to completing a disposition survey design, preliminary surveys can be used to obtain the necessary data.

The purpose of performing preliminary surveys is to obtain information describing the physical and radiological characteristics of the M&E. The ultimate goal is to minimize heterogeneity in the subset of M&E being surveyed. Minimizing heterogeneity helps to control the measurement uncertainties (see Section 5.6), and may be helpful in selecting a disposition option (see Section 2.5). For example, if a subset of the M&E is identified as difficult-to-measure while the majority of the M&E is relatively easy to measure and is considered for release, minimizing heterogeneity of all the M&E by segregating the difficult-to-measure subset for potential disposal may simplify measurements and be cost-effective. See Section 5.4 for information on segregation of M&E to minimize heterogeneity during implementation of the disposition survey design.

In general, preliminary surveys are designed using professional judgment to address specific questions concerning the existing data. Once a data gap has been identified, a survey is designed and implemented to obtain the information required to fill that data gap. The results of the survey are evaluated to ensure the data gap has been adequately addressed and the results are documented. In some cases these surveys will be large and complicated, with written survey designs reviewed by stakeholders prior to implementation. In other cases, these will be small ad hoc surveys that quickly provide some small piece of information required to proceed with the disposition survey design. By necessity, there is no single approach that will address all types of preliminary surveys. However, the DQO Process can be applied to successfully design a preliminary survey (EPA 2006a).

310 

311 **Figure 2.2 Assessing Adequacy of Information for Designing Disposition Surveys**

The first step in designing a preliminary survey is to identify the data gaps to be addressed. Section 2.4.1 and Section 2.4.2 discuss the minimum information required to describe the M&E and design a disposition survey. Any of the required information that is not available or is not of sufficient quality represents a data gap. In addition, there may be project-specific information needed to complete the disposition survey design that could also represent potential data gaps. In order to complete the list of potential data gaps, it is recommended that the planning team work through the entire disposition survey planning process (see Chapters 3 and 4). Whenever a data gap is identified, the planning team should make reasonably conservative assumptions or proceed with multiple survey designs based on a reasonable range of values to fill the data gap. Identifying a complete list of data gaps will help ensure the necessary additional information can be collected effectively and efficiently, with minimal waste of limited resources. If a separate preliminary survey is designed and implemented for every data gap as it is identified, there is an increased possibility of duplication of effort and increased demands on limited resources. As with all environmental data collection activities, QA and QC should be considered during planning and evaluated during assessment of the results.

2.4 Describe the M&E

The M&E being investigated must be described with regards to its physical and radiological attributes in order to establish the information necessary to design a survey approach that can adequately survey the M&E. This description is intended to ensure that residual radioactivity associated with the M&E will not be missed by the disposition survey, the M&E is left in a usable condition, and that any data collected meet the objectives of the disposition survey.

2.4.1 Describe the Physical Attributes of the M&E

A description of the physical characteristics defining the investigated M&E is required to help the user develop a disposition survey design. The preliminary physical description is usually developed using some combination of the techniques presented in Section 2.2 (i.e., visual inspection, historical records, and process knowledge). The physical description of the M&E is used to help define survey unit boundaries (see Section 3.6.1) and develop a decision rule (see Section 3.7), which has a direct impact on the disposition survey design.

Table 2.1 lists the four attributes that should be addressed when describing the physical characteristics of the M&E being investigated (dimensions, complexity, accessibility, and inherent value). Questions related to the evaluation of the attributes are provided, along with a list of minimum information expected to be provided by the IA. The planning team should consider designing and implementing preliminary surveys (see Section 2.3) to verify existing information and investigate data gaps identified during the initial steps of the IA.

2.4.1.1 Describe the Physical Dimensions of the M&E

It is important to understand the dimensions of the M&E being investigated in order to define the scale of decision making (see Section 3.6 on identifying survey unit boundaries), support evaluation of measurement techniques (see Section 3.8 and Section 5.9), and identify any handling issues that may need to be addressed (see Section 5.3). The dimensions are generally defined as the size and shape of the M&E being investigated. The size is primarily related to the scale of decision-making, and may be defined as the length, width, and depth of an item, or as the quantity of M&E. Quantity may be expressed in terms of a number (e.g., 25 pumps) or a volume (e.g., 200 cubic yards of concrete rubble), and may be related to the mass of the M&E. An estimate of the total mass of the M&E should be provided. The shape of the M&E is primarily related to the evaluation of measurement techniques. The description of shape should consider surface conditions (e.g., clean or dirty, rough or smooth, curved or flat) that affect the surface efficiency for radiation instruments. An estimate of the total surface area of the M&E should be provided when the radionuclides of concern are, or could be, surficial.

2.4.1.2 Describe the Complexity of the M&E

The complexity of the M&E also affects the disposition survey design. Complexity refers to the number and types of components that make up the M&E, as well as the ability to segregate or combine the M&E into similar groups. M&E consisting of a single component is a simple case. Consider the situation where several hundred feet of pipe are being investigated and the entire pipe is made from steel.

Table 2.1 Physical Attributes Used to Describe M&E

Attribute	Minimum Information	Questions for Consideration
Dimensions	Size (Total Mass) Shape (Total Surface Area)	Are there issues with size and shape that affect how the M&E should be handled?
Complexity	M&E may require segregation to design a technically defensible disposition survey. M&E may be combined into similar groups and still allow a technically defensible disposition survey.	Are there situations where segregation (e.g., disassembly) could affect the usefulness of the M&E? Are there situations where segregation (e.g., disassembly) could result in the release of radioactivity or hazardous chemicals to non-impacted areas? Are there situations where engineering controls are required to prevent the release of radioactivity or hazardous chemicals to non-impacted areas? Are there component materials that are inherently radioactive or hazardous? Are there multiple component materials in the M&E?
Accessibility	Identification of impacted, difficult-to-measure areas for performing conventional handheld measurements. Known or potential relationships between radionuclide concentrations or radioactivity in accessible and difficult-to-measure areas.	Are there issues with size or shape that limit accessibility (e.g., bottom of a large, bulky object)? Are there porous surfaces that could allow permeation of radioactivity? Are there seams, ruptures, or corroded areas where radioactivity could penetrate to difficult-to-measure areas?
Inherent Value	The inherent value of the M&E being investigated.	Can the M&E be reused or recycled? Can the M&E be repaired or remediated? What are the replacement and disposal costs?

A complex situation occurs when the M&E consist of a variety of component materials. Consider the same amount of pipe, but some pipe is steel, some is copper, and some is lined with rubber, lead, or PVC. Some types of process equipment (e.g., pipe originating from mineral processing industries) are internally lined with rubber, lead, or PVC. The presence of such liners can complicate the initial categorization, as well as subsequent characterization and survey of such equipment. The presence of lead can complicate the final disposition of process equipment (e.g., recycling as ferrous steel or disposal in landfills).

Equipment once used in process plants or systems should be checked for the presence of internally deposited sediment, sludge, oil, grease, water, and presence of process chemicals and reagents. The presence of such residues may require the implementation of special worker health and safety measures, procedures to collect and properly dispose of such hazardous material, and may restrict possible disposition options.

Complexity also comes from the ability to break down or combine the M&E into similar groups. A steel I-beam represents a simple case, where there is one material that can be cut into the desired lengths. Dispersible bulk materials represent a situation that is slightly more complex, especially when different types of materials have been combined. One example is a pile of scrap metal, where the metal can be segregated by material (e.g., aluminum versus steel) or type (e.g., sheet metal versus pipe versus I-beams).

Equipment tends to be more complex, because it often contains a variety of components that can generally be broken down by disassembling the equipment. Consider the case of a power tool consisting of a casing, an electric motor, and controls. There are different types of metal, plastic, and possibly glass or ceramics that make up the item, but disassembly into the individual components may render the tool unusable and may expose component materials that are inherently radioactive or hazardous. Disassembly of certain items could also result in the release of radioactivity or hazardous chemicals to non-impacted areas, and may require engineering controls to prevent such releases. The disposition survey design often increases in complexity as the equipment increases in size and complexity. However, complex M&E may also allow the user to segregate impacted from non-impacted items or components. This segregation may reduce the amount of M&E requiring additional investigation. One example is a front loader used to move piles of potentially radioactive material at a decommissioning or cleanup site. The bucket and tires of the front loader may be identified as impacted while the engine and cab are identified as non-impacted, depending on the controls in place while the equipment was being used. However, there may be cases where an adequate survey design cannot be developed based on decisions made earlier in the planning process. In these cases, it may be necessary to revisit some of the decisions made earlier, for example, re-evaluating the cost to benefit analysis.

2.4.1.3 Describe the Accessibility of the M&E

Accessibility is the next attribute to consider when describing the M&E being investigated. Accessibility has a direct impact on measurability, so it is a critical issue for making technically defensible disposition decisions. Areas (including surfaces and individual items) are accessible or difficult-to-measure. Accessible areas are areas where radioactivity can be measured, and the results of the measurement meet the DQOs and measurement quality objectives (MQOs) defined for the survey. During the IA it is necessary to distinguish areas that are accessible from areas that may be difficult to measure.

The determination of whether an area is accessible, for purposes of the IA, should be based on whether a measurement could be performed using a conventional hand-held radiation instrument such as a sodium iodide (NaI(Tl)) detector, or Geiger-Mueller (GM) Pancake probe. If difficult-to-measure areas are identified and these areas are categorized as impacted, the IA should attempt to identify if there are any known or potential relationships between radionuclide concentrations or radioactivity in accessible areas and radionuclide concentrations or radioactivity in difficult-to-measure areas. This information will be evaluated in Section 3.3.3 for the potential to use surrogate measurements as a method of estimating radionuclide concentrations or radioactivity in difficult-to-measure areas.

The potential for permeation and penetration of radioactivity should also be discussed as part of accessibility. Permeation describes the spread of radioactivity throughout a material and is usually associated with porous materials or surfaces (e.g., wood, concrete, unglazed ceramic). Certain chemical and physical forms can increase the permeation rate (e.g., liquids permeate faster than solids; small particles permeate faster than large particles). Penetration describes infiltrating or forcing a way into difficult-to-measure areas, and is generally associated with radioactivity entering through access points, seams, or ruptures. Corrosion of surfaces may also result in penetration of radioactivity into difficult-to-measure areas.

2.4.1.4 Describe the Inherent Value of the M&E

A part of describing M&E that is often overlooked during the IA is determining the inherent value of the materials or equipment being considered for release. Estimates of the value of materials and equipment should include the replacement cost, condition (i.e., can the materials or equipment be reused or recycled), and disposal cost. Replacement costs may consider increased productivity due to upgrades to existing facilities and equipment, decontamination costs for existing and new items, and the ultimate disposal of the replacements. Condition of the materials and equipment may include maintenance and repair costs to start or keep the items operational, as well as costs to decontaminate and release the items from radiological controls. Disposal costs may include shipping and handling of potentially hazardous material. The limited capacity of existing radiological waste disposal facilities may need to be considered along with the monetary cost of disposal.

2.4.2 Describe the Radiological Attributes of the M&E

A description of the radioactivity potentially associated with M&E being investigated is required to design a disposition survey. The review of historical documents (see Section 2.2.2) and process knowledge (see Section 2.2.3) are the primary sources of information on radioactivity associated with M&E. Sentinel measurements (see Section 2.2.4) may also provide information, such as types of radiations and identity of radionuclides. The information describing the radioactivity is used to support a decision of whether the M&E are impacted and supports the development of a disposition survey for impacted M&E. The description of the radioactivity is divided into four attributes: radionuclides, activity, distribution, and location.

Table 2.2 lists the four attributes to be addressed when describing radioactivity potentially associated with the M&E being investigated. Questions related to the evaluation of the attributes are provided, along with a list of minimum information expected to be provided by the IA. The planning team should consider designing and implementing preliminary surveys (see Section 2.3) to obtain information that is not provided by the IA.

Table 2.2 Radiological Attributes Used to Describe M&E

Attribute	Minimum Information	Questions for Consideration
Radionuclides	List of radionuclides of potential concern, including major radiations and energies.	What were the potential sources and mechanisms for the radioactivity to come into contact with the M&E?
Activity	List of expected radionuclide concentrations or radioactivity (e.g., average, range, variance) associated with the M&E List of known and potential relationships between radionuclide activities (e.g., activation and corrosion products, fission products, natural decay series).	What is the basis for the expected radionuclide concentrations or radioactivity? What is the basis for the known and potential relationships (e.g., process knowledge of similar sources, measurements of equilibrium conditions)?
Distribution	List of areas where the radioactivity is uniformly distributed. List of areas where the distribution of radioactivity is spotty. List of areas where the distribution is unknown.	Can the M&E be divided into sections where the distribution of radioactivity is uniform? Are there areas where small areas of elevated activity are a concern?
Location	State whether the radioactivity is surficial, volumetric, or a combination of both. State whether surficial radioactivity is fixed or removable.	Is the volumetric activity uniformly distributed, is there a gradient, or is the activity random or spotty?

2.4.2.1 Identify the Radionuclides of Potential Concern

Identification of the radionuclides of potential concern is a critical step in making disposition decisions. At a minimum, the planning team should review the information available from Section 2.2 to identify the radionuclides of potential concern. The quality and completeness of the existing information should be evaluated. Information on known or expected relationships between radionuclides of potential concern should be identified and evaluated for applicability to current conditions. If necessary, a study to identify a complete list of radionuclides of potential concern and determine relationships between radionuclides may be initiated before designing the disposition survey.

A list of radionuclides of potential concern should be developed based on existing data. The list should consider all potential sources of radioactivity, but only include radionuclides that are actually of concern for the M&E being investigated.

The list is designed to help focus the disposition decision. The list of radionuclides of potential concern should include the major types of radiation (e.g., alpha, beta, photon) and their corresponding energies. A discussion of the sources of radionuclides of potential concern, and their chemical and physical form should also be included, if possible.

Include a description of how the M&E became impacted if it is known. For example, it is important to document whether the potential radioactivity resulted from deposition of airborne particulate material, or from placing the M&E in an area of neutron flux that resulted in activation. All potential mechanisms for radioactivity to become associated with the M&E should be described.

A list of radionuclides of potential concern should be developed based on existing data. The list should consider all potential sources of radioactivity, but only include radionuclides that are actually of concern (e.g., potential to exceed an action level) for the M&E being investigated. The list is designed to help focus the disposition decision. The list of radionuclides of potential concern should include the major types of radiation (e.g., alpha, beta, photon) and their corresponding energies. A discussion of the sources of radionuclides of potential concern, and their chemical and physical form should also be included, if possible.

Include a description of how the M&E became impacted if it is known. For example, it is important to document whether the potential radioactivity resulted from deposition of airborne particulate material, or from placing the M&E in an area of neutron flux that resulted in activation. All potential pathways for radioactivity to become associated with the M&E should be described.

The description of potential radioactivity from the IA may also identify known or suspected relationships between radionuclides (e.g., equilibrium conditions for natural decay series, relative activities of fission products or activation products based on process knowledge). Additional investigations (e.g., preliminary surveys) may be performed to verify the presence of radionuclides of potential concern and provide estimates of the activity relationships between radionuclides. These investigations may include field measurements and sample collection with laboratory analysis.

The identification of radionuclides of potential concern may impact other decisions made during development of a disposition survey design. Since the sources of action levels are radionuclide or radiation-specific, the identification of radionuclides of potential concern directly affects the selection of an appropriate action level. The planning team should consider the impact of the list of radionuclides of potential concern on other decisions (e.g., selection of measurement techniques or instruments) as well as the impact of other decisions on the action levels when considering potential sources of action levels. For example, the identification of available measurement techniques (see Section 3.8) is also directly related to the radionuclides of potential concern. The determination of surficial or volumetric radioactivity (see Section 2.4.2.4) may be based on the energy and penetrating power of the radiation emissions, which would be indirectly related to the radionuclides of potential concern. Caution must be used in evaluating radionuclide concentrations or radioactivity for M&E with high levels of inherent background radioactivity.

2.4.2.2 Describe the Radionuclide Concentrations or Radioactivity Associated with the M&E

A description of expected radionuclide concentrations or radioactivity is also important for supporting disposition decisions for M&E. Radionuclide concentrations or radioactivity in excess of background (see Section 3.9 and Appendix B) support a finding that the M&E are impacted. Historical records (see Section 2.2.2) and process knowledge (see Section 2.2.3) are sources of information on radionuclide activities associated with M&E. In addition, sentinel measurements (see Section 2.2.4) can provide information on radionuclide concentrations or radioactivity. A description of the expected radionuclide concentrations or radioactivity should be developed for each of the radionuclides of potential concern. At a minimum, the average expected activity should be provided. Some assumption regarding the expected activity will be required in order to design a disposition survey using the guidance in Chapter 4. If no assumption can be made, a preliminary survey should be performed. If possible, information on the expected range and uncertainty (σ, as described in Sections 3.8.1 and 5.6) of the activity should be provided. The description of the expected activity should include the units, an estimate of uncertainty in the values, and a summary of how the data were obtained (e.g., purpose of data collection efforts, actual measurements, instrument used, count time, or process knowledge). Any known or suspected relationships between concentrations for individual radionuclides should be included in the description. For example, there is an expected relationship between fission products from a nuclear reactor because of the common source of the radionuclides (i.e., nuclear fission). Similarly, there is an expected relationship for activation and corrosion products. Members of the natural decay series (i.e., thorium series, uranium series, actinium series, see Appendix B) are also expected to have a relationship for activities based on equilibrium conditions.

2.4.2.3 Describe the Distribution of Radioactivity

The distribution of radioactivity is primarily concerned with whether the activity is spotty or more uniformly distributed throughout the item. A uniform distribution of activity has little spatial variability, so the radionuclide concentrations or levels of radioactivity are fairly constant. A spotty distribution of activity has high spatial variability, and small areas of elevated activity are present as well as areas with little or no activity above background. The expected distribution of radioactivity could include areas with uniform radionuclide concentrations or levels of radioactivity and areas where the radionuclide concentrations or radioactivity is non-uniform. For example, airborne deposition could have produced a uniform distribution of radioactivity on horizontal exterior surfaces, while penetration through seams and access points could result in spotty radioactivity on interior surfaces. In addition, the interior surfaces could have a uniform distribution of radioactivity over localized areas (e.g., areas around a vent or cooling fan). Concentrations of radionuclides on M&E can change over time due to in-growth, decay, or diffusion.

2.4.2.4 Describe the Location of Radioactivity

The location of radioactivity is primarily concerned with whether the activity is located on the surface or distributed throughout the volume of the M&E. Surficial radioactivity is restricted to the surface of the M&E and is further described as removable, fixed, or some combination of these two. Removable (or non-fixed) radioactive material is radioactive material that can be readily removed from a surface by wiping with an absorbent material. Fixed radioactive material is not readily removed from a surface by wiping. Surficial radioactivity is generally associated with non-permeable solid M&E. Volumetric radioactivity is not restricted to the surface of the M&E and is usually associated with permeable materials, surfaces, or activation by neutrons or other particles.

The question of surficial vs. volumetric radioactivity is a complicated issue that may or may not have a significant impact on the disposition survey design. The description of the location of radioactivity used to design the survey may be independent of where the radioactivity is physically located. For example, consider two different methods for surveying ^{60}Co activity concentrations distributed on the surface of several thousand small bolts. First, the bolts may be surveyed in a container using in situ gamma spectrometry assuming the radioactivity is volumetrically distributed.[3] If the same bolts are surveyed individually using a conveyorized survey monitor the conceptual model may describe the ^{60}Co as surficial radioactivity.

In some cases, the location of the residual radioactivity may be well known. For example, surface deposition of radioactivity on a non-porous material (e.g., smooth stainless steel) will not penetrate into the material to a significant extent under most conditions, so the residual radioactivity could be identified as surficial. Activated materials and bulk quantities of materials usually have volumetric residual radioactivity, although surficial radioactivity may also be present. On the other hand, the actual location of the residual radioactivity may be less well known or unknown.

Process knowledge is the primary source of information on the location of residual radioactivity. The planning team should review the information from Section 2.2.3 to determine the expected location of residual radioactivity and the level of knowledge (i.e., well known, less well known, unknown) associated with the information.

When the location of the residual radioactivity is well known, the planning team should proceed with a survey design based on the appropriate assumption, surficial or volumetric. When the

[3] This example does not imply that any measurement technique should be applied to every situation. The information in Section 3.8 should be used to develop the measurement quality objectives (MQOs) for a project. The MQOs can be used to evaluate measurement techniques against the action levels and select the techniques best suited for a specific application.

location is less well known or unknown, the planning team may choose to proceed with multiple survey designs to determine the possible effect the location of the residual radioactivity may have on the design of the disposition survey.

2.4.3 Finalize the Description of the M&E

A final description of the M&E should be prepared following implementation of any preliminary surveys. The description of the M&E should consider the information in Table 2.1 and Table 2.2 and provide sufficient information to design the disposition survey.

2.5 Select a Disposition Option

The disposition of the materials and equipment will be a key factor in designing the disposition survey. MARSAME broadly considers two types of disposition decisions: release and interdiction. Release surveys are used to determine whether radiological controls can be reduced, removed, maintained at the current level, or transferred to another qualified user. Interdiction surveys are used to initiate radiological control, or to decide current radiological controls are adequate.

Examples of potential disposition options for release of impacted M&E include:

1. Reuse in a controlled environment.
2. Reuse without radiological controls (i.e., clearance).
3. Recycle for use in a controlled environment (i.e., authorized disposition).
4. Recycle without radiological controls.
5. Disposal as industrial or municipal waste.
6. Disposal as low-level radioactive waste.
7. Disposal as high-level radioactive waste.
8. Disposal as transuranic (TRU) waste.
9. Maintain current radiological controls.

Examples of potential disposition options for interdiction of impacted M&E include:

1. Initiation of radiological controls for M&E identified by an interdiction survey.
2. Decision not to accept M&E following an interdiction survey.
3. Approval for continued radiologically unrestricted use of the M&E.

The selection of a disposition option should be based on the information available at the end of the IA. The disposition option (e.g., reuse, recycle, disposal, initiation of control, or refusal) defines the action level (see Section 3.3). The expected radionuclide concentrations or levels of radioactivity associated with the M&E (see Section 2.4.2) are compared to the action level to determine whether the M&E will be controlled or uncontrolled following the disposition survey. The disposition option also defines the alternative actions for the decision rule to be developed in Section 3.6. Different disposition options may be applied to separate parts of equipment. If so, implementation of the different dispositions implies the necessity for total or partial disassembly. For example, it may be possible to remove a bucket from a backhoe for disposal and allow reuse of the rest of the equipment.

2.6 Document the Results of the IA

The results of the IA should be documented to the extent necessary to support the decisions made. The level of documentation required will depend on the amount of information collected, the quantity of M&E covered by the IA, the type of assessment (e.g., standardized or project-specific), and, as applicable, administrative and regulatory requirements. Two options for documenting the assessment results are the Standardized IA and the Conceptual Model as described in the following sections. Figure 2.3 illustrates documentation of the IA.

2.6.1 Standardized IA

A standardized IA is a set of instructions or questions that are used to perform the IA. These instructions are usually documented in an SOP. The SOP should be developed, reviewed, and documented in accordance with an approved Quality System. Information on developing and documenting a functional quality system can be found in EPA QA/G-1 (EPA 2002c). Guidance on developing SOPs as part of a quality system can be found in EPA QA/G-6 (EPA 2001).

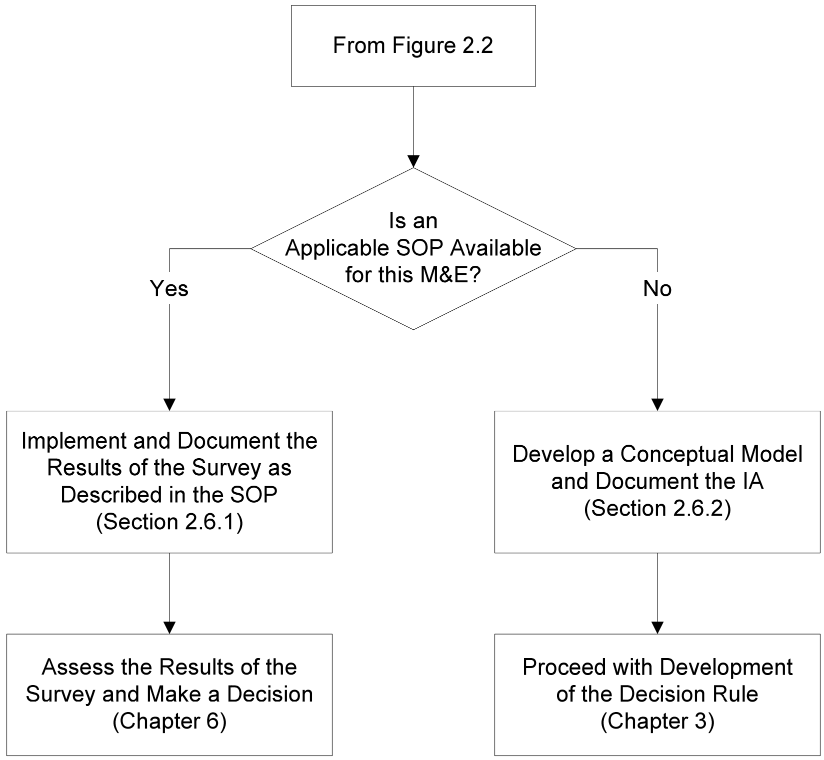


Figure 2.3 Documentation of the Initial Assessment

A standardized IA is generally associated with facilities or processes that regularly evaluate similar types of M&E. The release of small tools and personal items from an operating nuclear plant is one example of such a process. Another example, this time describing an interdiction process, would be evaluating truckloads of scrap metal entering a recycle facility. SOPs may be developed to describe repeated routine surveys of similar M&E for both situations.

The documentation of the IA results is described in the SOP. The documentation should be sufficient to demonstrate that trained personnel using an approved SOP evaluated all potentially impacted M&E. For a standardized IA, all these records are maintained but may not be directly associated with the IA. Individual records for each item evaluated by an IA are not required.

The SOP should clearly describe its scope and the applicable types of M&E. This information may be useful for determining whether the M&E are impacted as well as whether the SOP can be used to evaluate the M&E. For example, if the SOP is applicable to all M&E used for a certain process or within a certain part of a facility, this defines what M&E can be considered impacted by that process.

The SOP should also describe the M&E that were used to develop the instructions. The description of the M&E being investigated (see Sections 2.2 and 2.3) should be compared to the assumptions used to develop the instructions to determine if the SOP is appropriate. For example, it may be appropriate to apply an SOP developed for scrap metal to evaluate hand tools, since both are made from metal and may have similar surface radioactivity. Alternatively, it may not be appropriate to use an SOP developed for scrap metal to evaluate dry active waste or concrete rubble, since they may have volumetric activity and different surface efficiencies. At a minimum, the rationale for applying the SOP to M&E other than specified in the SOP should be documented.

The SOP should include the training requirements for personnel implementing the SOP. Personnel performing the IA should be familiar with the SOP being implemented, as well as the potential disposition options implied or explicitly stated in the SOP.

Additional documentation may be needed when the SOP is applied to situations other than those considered during development of the SOP. The purpose of the additional documentation is to determine whether the SOP may be applicable to a wider range of M&E. This documentation will help provide technical support for modifying the SOP. If incorrect decisions are made concerning the determination of whether M&E are impacted, or inappropriate recommendations are made for disposition options, it may be necessary to modify the SOP to reduce the number of decision errors. The additional documentation will help identify the source of the decision errors and help provide technical support for modifying or revising the SOP.

2.6.2 Conceptual Model

If a standardized IA approach is not available for the M&E being investigated, the results of the IA should be documented in a conceptual model. If the information in MARSAME is being used to develop a standardized survey design (e.g., a new SOP), the information on developing a conceptual model applies.

The conceptual model is applied in case-by-case situations and decisions. The conceptual model describes the M&E and radioactivity expected to be present for the project. The definition of impacted and non-impacted as it applies specifically to the project should be included in the conceptual model. The conceptual model describes the processes involving radioactive materials, as well as how the radioactivity could become associated with the M&E.

The description of the M&E documents the results of the IA investigation. At a minimum the conceptual model should include a description of the physical attributes of the M&E (see Section 2.4.1 and Table 2.1), the radiological attributes of the M&E (see Section 2.4.2 and Table 2.2), and a list of the applicable disposition options (see Section 2.5). In addition, the conceptual model helps identify data gaps and develop potential collection strategies for filling data gaps.

The conceptual model will serve as the basis for the information and assumptions used to develop the disposition survey design in Chapter 4. In many cases the information in the conceptual model will be included in either the survey design documentation or in the documentation of the results of the disposition survey. The structure and content of the conceptual model should be based primarily on the future uses of the data.

The planning team should review the information on radionuclides of potential concern provided by the IA for consistency with the conceptual model. If the data appear incomplete or the quality of the data is not adequate for the disposition survey being designed, the planning team may decide that additional information needs to be collected using preliminary surveys before proceeding with the survey design.